$n$ couples $\{(h_i, w_i)\}$, where $h_i$ and $w_i$ are husband and wife of couple $i$, go to a movie theater and are seated in one row. Each person, except two seated at the two ends, has two neighbors. It is required that each neighbor of a person $k$ either has the same gender as $k$ or is the spouse of $k$. A reasonable pattern is an assignment of $n$ couples without indices that meet the above requirement. For example, when $n = 3$ all reasonable patterns are as follows:

$$wwwhhh, hhhwww, whhwhw, wwhhww, hwwhww, wwhhhw, hwwhwh, hhwwwh$$

An indirect solution enumerates all patterns and, then, eliminates all un-reasonable (not reasonable) patterns by printing out reasonable patterns only. A direct solution systematically generates all reasonable patterns directly. You are required to provide solutions to print out all reasonable patterns using both indirect and direction solutions.

Submit a hardcopy of your project including the following four sections:

1. (no more than 5 pages)
   Explain each solution in plain English first and, then, pseudo code. Specifically, pseudo code includes the way to enumerate all patterns in the indirect solution and the way to enumerate all reasonable patterns in the direct solutions.

2. (no page limit)
   Write a C, C++, or Java code that will print out the following items for a given $n$:
   (a) the number of patterns (in the indirect solution)
   (b) all reasonable patterns
   (c) the number of reasonable patterns

   Attach a hard copy of your code.

3. (no more than 2 pages)
   Print out items (a) to (b) in section 2 for $n = 6$. 


4. (no more than 1 page)

Tabulate execution time of each solution for \( n = 5, 6, 7, 8, \) and 9 using the given format below. Provide a critical comparison between the indirect solution and the direction solution. Summarize the project using one paragraph.

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>pattern (indirect)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pattern (direct)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Arrange your report in the order of sections 1, 3, 4, and, then, section 2.
- Late submission will be penalized.
- Page limit will be strictly enforced.
- Handwritten report is not acceptable.